interfer nce paints

paint

watercolor

"Luster" pigments are a minor innovation in artist's materials, brought in from decorative applications in crafts and cosmetics, which in turn had adopted them from the sparkly textures first used in consumer packaging and plastics. **Mayer** sniffs that iridescence effects "have little to do with painting but often occur in nature" -- which is half true.

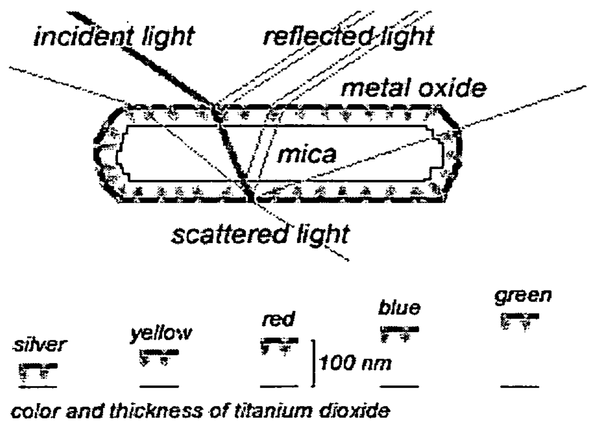
The first interference pigment was **guanine**, a protein crystal found in the scales, skin and bladder of many species of whitefish (such as sardines or herrings). The first pearlescent (or **nacreous**) pigment was developed in 1656 by the French rosary manufacturer François Jaquin, who made artificial pearls by painting guanine on round beads. Natural **pearl essence** is prized for its toughness, and the subtle warmth of its iridescent color; it is primarily used in shampoos and cosmetics.

A considerable amount of research was required before the structure of iridescent pigments was understood and artificially imitated. The breakthrough was the use of **mica**, a type of hydrated crystal of aluminum, magnesium or potassium silicates that naturally forms into extremely thin, flexible, transparent sheets. The mica used in artist's paints is usually **muscovite,** obtained either from mining scrap that is ground into powdery flakes, or (more commonly) crystallized synthetically to the required dimensions. Mica based interference pigments were introduced in the 1960's and today make up about 80% of the total interference pigments sold.

These tiny, transparent mica flakes are coated on all sides with a thin layer of **metal oxide** -- either iron oxide or titanium dioxide. These

metal oxides are highly refractive (they can bend light) and reflective. Water, for example, has a refraction index of 1.33; mica, 1.5; natural pearl, 1.9; diamond, 2.4; iron oxide, 2.4; and titanium dioxide, 2.7.

The diagram below shows how these pigments work. The coating of metal oxide creates a sandwich of different refractive materials: light is bent and reflected at the boundaries between the paint vehicle, metal oxide, and mica. (Natural pearl creates iridescence from the boundaries between alternating layers of calcium carbonate and protein.)



how iridescent pigments work

The metal oxide layer reflects light twice, from the outer surface and from the boundary with the mica flake (this double reflection happens again on the other side of the flake). The delay between the first and second reflection slightly phase shifts the wavelengths of light. The shift cancels out some wavelengths of light and reinforces others -- these reinforced wavelengths are those of the dominant color of the iridescence.

The thickness of the metal oxide layer determines the size of this phase shift, and so determines the color of the iridescence. The lower section of the diagram shows, for

coatings of titanium dioxide, that layers around 50 nm thick produce a silvery iridescence; increasing the coating changes the iridescence through yellow, red, blue and green. The brilliance of the iridescence declines if the coating is much thicker than 150 nm.

The alternative coating, iron oxide, refracts light in much the same way as titanium dioxide, but adds the reddish tinge characteristic of iron pigments. The same increases in thickness from 50 nm to 150 nm produce colors that appear bronze, copper, red, red-violet or red-green. Gold and brown colors can be produced by applying a layer of iron oxide on top of a layer of titanium oxide.

In addition to these coated mica flakes, the paint often contains a transparent carrier pigment, usually one of the **quinacridones** or a **transparent iron oxide**. This provides a background color for the iridescence, which by itself largely disappears on white paper.

The image shows several shades of interference and iridescent paints from **Daniel Smith** (Pearl Ex also makes pearlescent watercolor paints).